EP-1752

A study of suitable conditions for stereotactic radiation therapy using VMAT for lung cancer

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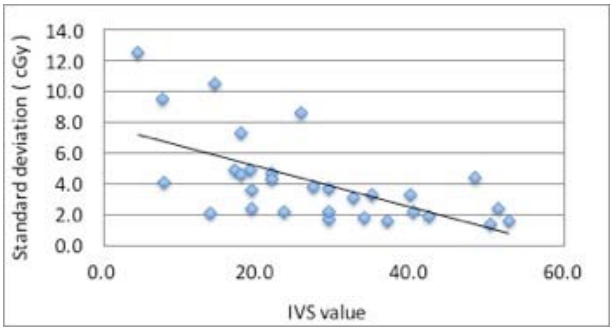
Purpose or Objective: The dose variation of stereotactic body radiation therapy using volumetric modulated arc therapy (VMAT SBRT) for lung cancer varies due to the interplay effect between multileaf collimator (MLC) motion and tumor motion. The aim of this study was to assess the relationship between dose variation and factors related to the interplay effect and clarify optimal conditions for VMAT SBRT.

Material and Methods: Respiratory motion data and MLC motion data were obtained from 30 patients who underwent treatment with VMAT SBRT for lung cancer. We calculated number of breaths (NB) during irradiation, maximum craniocaudal tumor motion (Amp), and MLC motion complexity (MCSv, modulation complexity score applied to VMAT). Parameters assessed for each treatment plan were MCSv, a divisor combination of Amp and MCSv (AmpMCSv), and a multiplier combination of AmpMCSv and NB (IVS, interplay effect variable score). Static and dynamic measurements were performed with a PinPoint chamber (0.015cm3, PTW, Germany) in a Quasar phantom (Modus Medical Devices, Canada). Pearson's correlation analysis was used to assess the effect of dose variation on individual parameters.

Results: A wide range of NB (28.9 to 100.7 times) was observed. The standard deviation of dynamic measurement ranged from 1.3 to 12.5 cGy. Dose variation was negatively correlated with AmpMCSv (r = −0.52, p < 0.05) and IVS (r = −0.62, p < 0.05). IVS was obtained stronger correlation than AmpMCSv by considering NB. Significant dose variation was found in cases with the lowest NB (28.9 times).



Conclusion: Patients that had fewer than 40 NB, <150 s irradiation time, and a respiratory cycle of >4 s had the highest dose variation, and therefore required careful attention during VMAT SBRT treatment.

EP-1753

Intrafraction setup variability for breast Helical Tomotherapy

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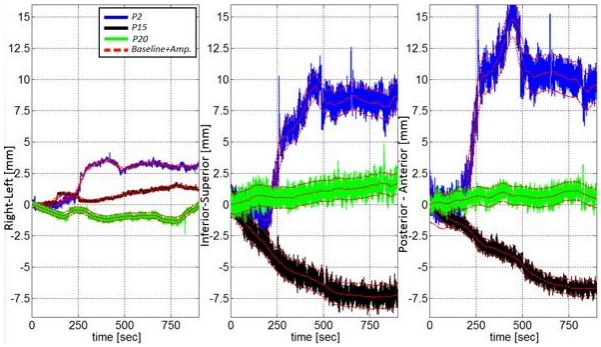
Purpose or Objective: To investigate intra-fraction breast motion during long-lasting (10-20 min) breast Helical Tomotherapy (Accuray, Madison, WI, USA) by means of optical tracking.

Material and Methods: Twenty locoregional breast cancer patients underwent Helical Tomotherapy irradiation after receiving conservative surgery or mastectomy. Non-invasive monitoring of respiratory motion during the entire treatment course, from setup verification to dose delivery, was achieved through infrared tracking of a passive marker placed near the surgical scar. In order to obtain the displacement deriving from the patient movement only, we subtracted the trace of an additional marker placed on the treatment couch. Respiratory signals were analyzed in terms of peak-to-peak amplitudes and baseline drifts, obtained by low-pass moving average filtering with a time window of 60 sec. Anisotropic Clinical Target Volume (CTV) safety margins expansion due to intrafraction organ motion was calculated relying on a synthetic representation of the specific patient respiratory pattern, obtained by adding half of the most probable respiratory amplitude to the non-respiratory movement of the scar trace in each anatomical direction (Fig.1).



Results: The most probable measured breathing amplitudes among all patients was (median±inter-quartile range): 0.25±0.12 mm (right-left), 1.31±0.63mm (inferior-superior) and 1.22±0.70 mm (posterior-anterior). Each patient featured a small inter-fraction variability of expected motion ranges, thus confirming a good reproducibility of respiratory motion during the entire course of treatment. Scar baseline drifts were mostly in posterior and in the inferior direction for all patients in most fractions, with the exception of patient *P2,* who exhibited a relevant baseline shift in superior and anterior direction with a large variability (Tab.1). The distribution of right-left shifts resulted in almost zero median, with a narrow interquartile range. Patient *P20* showed stationary breathing, with a median baseline shift around zero in all anatomical directions. Conversely, patient *P15* had a wide inferior-superior and posterior-anterior motion with large interquartile ranges. Resulting anisotropic safety margin expansions across all patients with the exception of *P2*, considered an outlier, were 1.58-2.44 mm in right-left, 4.41-3.65 mm in inferior-superior and 3.78-2.15 mm in the posterior-anterior directions, respectively.